

CLAIMS

Sub A1
1. A cellular telephone a multi-band antenna apparatus comprising:
a multi-band antenna; and
a grounded helical antenna surrounding the multi-band antenna.

Sub C2
2. The multi-band antenna apparatus as in claim 1 further comprising:
a cellular telephone housing formed of a conductive material; and
a printed circuit board (PCB) carried by the cellular telephone housing, the
PCB having a metalized ground plane, the metalized ground plane and the grounded
helical antenna coupled to the cellular telephone housing.

Sub A2
3. The multi-band antenna apparatus as in claim 2 wherein the multi-band antenna
comprises a helical antenna coupled to a monopole antenna.

4. The multi-band antenna apparatus as in claim 3 wherein the grounded helical
antenna includes turns around a linear axis, a distance between at least some adjacent
turns of the grounded helical antenna varying along the linear axis.

5. The multi-band antenna apparatus as in claim 4 wherein the grounded helical
antenna comprises a top section and a lower section along the linear axis, the lower
section coupled to the metalized ground plane and the top section located at an end
opposite the lower section along the linear axis, a distance between adjacent turns of
the top section narrower than a distance between adjacent turns of the lower section.

Sub A3
1 6. A cellular telephone antenna comprising:

2 an inner antenna; and

3 a radio frequency (RF) grounded helical antenna surrounding the inner
4 antenna, the RF grounded helical antenna including,

5 a first section having a distance between adjacent turns of a first predetermined
6 amount, and

7 a second section having a distance between adjacent turns of a second
8 predetermined amount, the second predetermined amount less than the first
9 predetermined amount.

10 7. The cellular telephone antenna as in claim 6 wherein a resonant frequency of the
11 RF grounded helical antenna is substantially equal to a resonant frequency of the inner
12 antenna.

13 8. The cellular telephone antenna as in claim 6 further comprising:

14 a cellular telephone housing formed of a conductive material; and
15 a printed circuit board (PCB) carried by the cellular telephone housing, the
PCB having a metalized ground plane, the metalized ground plane and the RF
grounded helical antenna coupled to the cellular telephone housing.

6 9. The cellular telephone antenna as in claim 6 wherein the inner antenna comprises
7 an inner helical antenna.

Sub A4
8 10. The cellular telephone antenna as in claim 9 wherein a resonant frequency of the
9 RF grounded helical antenna is substantially equal to a resonant frequency of the inner
10 antenna.

11 11. The cellular telephone antenna as in claim 10 further comprising:

12 a cellular telephone housing formed of a conductive material; and
13 a printed circuit board (PCB) carried by the cellular telephone housing, the
14 PCB having a metalized ground plane, the metalized ground plane and the RF
15 grounded helical antenna electrically coupled to the cellular telephone housing.

1 12. A cellular telephone antenna comprising:

2 a monopole antenna tuned to a first resonant frequency of operation;

3 a first helical antenna coupled to the monopole antenna and having turns

4 surrounding the monopole antenna, the first helical antenna tuned to a second resonant
5 frequency of operation; and

6 an electronically grounded second helical antenna surrounding the first helical
7 antenna, the electronically grounded second helical antenna formed to have an upper
8 capacitive loading segment to tune the electronically grounded second helical antenna
9 at substantially the second resonant frequency of operation.

13. The cellular telephone antenna as in claim 12 further comprising:

2 a cellular telephone housing formed of a conductive material; and

3 a printed circuit board (PCB) carried by the cellular telephone housing, the
4 PCB having a metalized ground plane, the metalized ground plane and the
5 electronically grounded second helical antenna coupled to the cellular telephone
6 housing.

1 14. A cellular telephone comprising:

2 transmitter for transmitting signals;

3 a receiver for receiving signals;

4 a synthesizer coupled to the transmitter and receiver for generating carrier
5 frequency signals;

6 a controller for controlling operation of the cellular telephone;

7 a first helical antenna coupled to the transmitter and the receiver, the first
8 helical antenna tuned to a resonant frequency of operation; and

9 a grounded helical antenna surrounding the first helical antenna, the grounded
10 helical antenna formed to have a first section of adjacent helical turns that are spaced
11 farther apart than adjacent helical turns of the first helical antenna, the grounded
12 helical antenna formed to have an upper capacitive loading segment to tune the
13 grounded helical antenna to substantially the resonant frequency of operation.

14 15. The cellular telephone as in claim 14 further comprising:

15 a cellular telephone housing formed of a conductive material; and

16 a printed circuit board (PCB) having a metalized ground plane, the metalized
17 ground plane and the grounded second helical antenna coupled to the cellular
18 telephone housing.

19 16. The cellular telephone as in claim 15 further comprising a monopole antenna
20 coupled to the first helical antenna and tuned to a second resonant frequency of
21 operation.